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THE UNIVERSITY OF FLORIDA-IFAS LIVESTOCK WASTE TESTING LABORATORY

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Abstract. **The University of Florida-Institute of Food and Agricultural Sciences (UF-IFAS) Livestock Waste Testing Laboratory (LWTL) has conducted analytical testing of livestock wastes and made recommendations for their use in fertilization of vegetable and agronomic crops since 1991. The UF-IFAS LWTL was begun with a United States Department of Agriculture (USDA) Hydrologic Unit Area grant in the early 1990s. The purpose of the grant was to provide livestock waste testing, analytical results interpretation, and education for manure management in the Middle Suwannee River Area of northern Florida, home for many dairy and poultry operations. Today, the LWTL scope has expanded to the whole state and operations are funded by grants from a consortium of agencies, including UF-IFAS, Florida Department of Agriculture and Consumer Services (FDACS), USDA Natural Resources Conservation Service (USDA-NRCS), The Suwannee River Water Management District (SRWMD), and poultry and dairy organizations such as GoldKist and Sunshine State Milk Producers. The LWTL is very active assisting with the increasing demand for educational information about agricultural waste management associated with crop nutrient BMPs and water quality incentive programs. Each year the LWTL performs several thousand individual analyses on manure waste samples, largely from poultry and dairy farms, from all over Florida. LWTL workers assist researchers and extension specialists with research and demonstration projects on manure management with vegetables and agronomic row crops. For example, in previous research, mulched eggplant, muskmelon, and watermelon responded positively to poultry manure to 6 ton/acre, providing N of about 150 lb/acre. On-farm demonstrations have been carried out with muskmelon. This paper will summarize the results of 12 years of agricultural waste analyses, nutrient management recommendations, and research with vegetables.**

The University of Florida-Institute of Food and Agricultural Sciences (UF-IFAS) began a program of analyzing livestock wastes in the Middle Suwannee River Area (MSRA) in the early 1990s with a USDA Hydrologic Unit Area grant. The MSRA is located along the Suwannee River in north central Florida and extends from the mouth of the Withlacoochee River near Ellaville to the point south of Branford where the Suwannee and Santa Fe rivers meet. The area lies within the borders of four counties: Suwannee, Lafayette, Madison, and Columbia counties. The total drainage area is approximately 540,000 acres, with 83% of the basin located in Suwannee and Lafayette counties.

The MSRA is a Karst region of porous limestone, highly permeable sandy soils, and numerous sinkholes (Katz and Dehan, 1996). These characteristics allow rainwater to directly infiltrate the unconfined Floridan Aquifer, making the region a major recharge area to the Floridan Aquifer. These characteristics also make the MSRA highly susceptible to nonpoint-source pollution. The Floridan Aquifer is the source of drinking water for the residents in the MSRA. In addition, seeps and springs flow from the Floridan Aquifer into the Suwannee River and there is concern that polluted groundwater recharge to the river could degrade the river water quality. The Suwannee River has been designated an Outstanding Florida Water and is considered by many to be a river of national significance (Fla. Dept. Environ. Protection, 1999).

The MSRA is home to widespread agricultural crop production, especially agronomic crops (Bahiagrass pasture, Bermuda grass hay, and silage corn) and vegetable crops (watermelon, potato, pepper, sweet corn, and snap bean). Farmers are taking advantage of the mild climate, abundant available land, and high-quality irrigation water. However, the sandy soil characteristics that have attracted farmers, especially vegetable farmers, to the MSRA also make the groundwater vulnerable to nitrate contamination. Growers need educational information and analytical services to help them make appropriate decisions regarding nutrient management.

Profitable crop production in the MSRA requires nitrogen (N) fertilizer and irrigation water. Agricultural crop producers are using profitable highly intensive production practices and sometimes large quantities (often exceeding the University of Florida Extension recommendations) of fertilizers are used to produce high quality crops. Considerable research by the University of Florida spanning more than 50 years, including work conducted in the MSRA, has led to the current University of Florida Extension recommendations for fertilization and irrigation of vegetables and agronomic crops. This research also has involved manure management with vegetables and these research results have been incorporated in the fertilization recommendations from the Livestock Waste Testing Laboratory (LWTL).

Livestock production is very prevalent in the MSRA, with approximately 60,000 head of cattle (Anonymous, 2002) and more than 140 poultry growers (Smith, 2002a, b). Most of these dairy and poultry operations are currently upgrading their waste management systems, reducing their potential for leaching nitrates during manure collection and storage. Manure is sold and transported off-site, or is land-applied to nearby crop producing fields.

The poultry industry in northern Florida produces approximately 4,000 lb of manure for every 1000 birds (Mitchell et al., 1990), and there are approximately 150 million birds in the Suwannee River Valley area. The importance of choosing an appropriate rate of manure has been emphasized by Sims (1986). Factors affecting the selection of appropriate manure rates for crop fertilization include crop N, P, and K requirements, soil-test P and K results, N mineralization rate in the soil, method and timing of manure application, and previous

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cropping history (Douglas and Magdoff, 1991; Mathers and Goss, 1979). Previous work with poultry manures in Florida with strawberry documented optimum rates for crop production and reduced growth and fruit yield with excessively high rates of manure (Albregts and Howard, 1981). Observations from studies involving successive crop production on manured soils in Florida showed that mineralization rates in Florida are great enough that little N remains after the first vegetable crop (Hochmuth et al., 1992).

In recent years, scientists with the Suwannee River Water Management District (SRWMD) have been documenting a trend of increasing nitrate levels in the Suwannee and Santa Fe River basins (Smith, 2002a, b). Annual nitrate-N loadings to the Suwannee River estuary near the Gulf of Mexico totaled nearly 3,000 tons during 2001. Over 45% of the total nitrate load was introduced to the ground and surface water system in the MSRA (Hornsby et al., 2002). Agriculture is considered a potential source for the nitrate loadings (Katz and Dehan, 1996). Therefore, agricultural crop producers need analytical services for manures and educational information on nutrient management.

LWTL Formation, Purpose, and Operation

The LWTL was formed in 1991 through a USDA Hydrologic Unit Area Grant under the supervision of University of Florida scientists Drs. Roger Nordstedt and Jerry Kidder. The LWTL was designed to initiate educational programs about livestock waste management to reduce or prevent water quality degradation of the Floridan Aquifer and the Suwannee River from agricultural operations. The LWTL has two basic purposes in serving agricultural producers in the Suwannee River Basin: 1) to provide a credible testing lab that provides users with an objective and accurate laboratory analysis of the livestock waste products and interpretation of the lab results, and 2) to serve as a source of educational information for livestock waste management for crop production.

Nutrient concentrations in various livestock wastes can vary greatly. Even manure samples from the same location can vary greatly over time. The LWTL analyzes animal waste samples to determine the levels of the major plant nutrients present in the waste. The LWTL estimates the total N colorimetrically following Kjeldahl digestion (Peters et al., 2003). Ammonia is determined by distillation, followed by titration. Total phosphorus is determined by acid persulfate digestion, and total potassium is estimated using an ion selective electrode specific for potassium. Other analyses performed for each sample include total solids, ash, and pH using an Orion 720 pH meter. These data are then entered into a custom-designed spreadsheet for creation of the analytical report and recommendations.

The analytical report generated by the LWTL presents the results as analyzed, and then converts these results into fertilization recommendations familiar to growers. Included are estimations of potential N and ammonia losses in the field, the University of Florida Extension recommended nutrient application rates for the grower's specific crop, and the recommended manure application rate, based on the lab analyses. Further, the report informs the producer of the manure's economic value compared to using commercial chemical fertilizers to provide the nutrients.

Over its history, the LWTL has been funded by a consortium of federal and state agencies, which have allowed samples to be analyzed at no charge to the user. The Florida Department of Agriculture and Consumer Services, SRWMD, UF-IFAS, USDA-Natural Resources Conservation Service, Florida Department of Environmental Protection, Sunshine State Milk Producers, and Goldkist have contributed funds supporting the LWTL. A sample charge is applied to submissions received from grant-funded research projects. The full services of the LWTL remain free to agricultural producers, supporting on-farm nutrient management planning.

Educational Outreach

In addition to several of the LWTL's founders' active participation over the years, UF-IFAS supports a new professional position created to coordinate the UF-IFAS LWTL Nutrient Management Education Program with livestock wastes in the MSRA. This position increases the capacity of UF-IFAS, through the county extension agents, to provide educational programs in livestock waste and nutrient management planning, and resource development. These educational programs include field days, on-farm demonstrations, and educational presentations.

Components of the LWTL Nutrient Management Education Program are also designed to support the goals of the Suwannee River Partnership, which is a coalition of 24 federal, state, and local government agencies working together with industry partners to reduce nitrate loadings to the MSRA using a voluntary, incentive-based approach. Goals of the Partnership include reducing nitrate loadings to the basin and developing agricultural nutrient management practices that will reduce nitrate leaching potential on farms.

12 Years of Nutrient Analyses.

During the last 12 years, the LWTL has received nearly 4,500 manure samples for analysis, comprising 31 separate classifications of manure. Of these samples, 2,438 were selected and grouped into seven basic classifications according to their similarity of composition as collected. The results of these analyses were then averaged to give a representation of the manure characteristics within the MSRA (Tables 1 and 2).

Dairy solids within the MSRA are most often wet, having an average moisture content near 70%, which reduces the nutrient concentration of the waste material. On average, the nutrient content of fresh dairy solids is about 6 lb per ton of nitrogen (N), 1 lb per ton of elemental phosphorus (P), and 2 lb per ton of elemental potassium (K). Application rates of this material can frequently exceed 10 tons per acre to meet the N requirement of the crop.

Dairy effluent also contains substantial concentrations of N, averaging 91 lb of N, 22 lb P, and 81 lb K per acre-inch of land-applied effluent. Dairy waste management systems use tremendous volumes of water to flush the manures into collection areas to provide a clean and healthy environment for the cattle. The large volumes of water make effluent costly to transport large distances from the farm, so the effluent is collected in large storage ponds on the farm. These waste storage ponds, or lagoons, can contain hundreds of thousands of gallons of effluent, and application is limited to the system's capacity to filter and pump the effluent to the distant fields.

Poultry broiler litter remains the most abundant livestock waste available for off-site transportation. Nutrient values of broiler litter are much more consistent than either dairy solids

Table 1. Average nutrient content and other characteristics from 1275 samples of solid manure collected in the Middle Suwannee River Area of Florida from 1991-2003.

Description of materials	pH	Solids	Ash	TKN[z]	Ammonia N	Total P	Total K
		(lb per ton)					
Dairy solids	6.8	650	378	6	1	1	2
Poultry broiler litter	7.7	1545	489	50	9	27	48
Poultry layer litter	8.1	1339	710	32	7	25	33
Composted dairy solids	8.6	1227	753	15	2	8	20
Composted poultry broiler litter	7.6	1537	491	51	10	31	43
Composted poultry mortality	7.8	1484	522	49	11	32	40

[z]TKN is total kjeldahl nitrogen.

Table 2. Average nutrient content and other characteristics of 1163 samples of liquid dairy manure collected in the Middle Suwannee River Area of Florida from 1991-2003.

Description	pH	Solids	Ash	TKN[z]	Ammonia N	Total P	Total K
		(lb per acre-inch of applied effluent)					
Dairy effluent from storage lagoon	7.2	2377	960	91	39	22	81

[z]TKN is total kjeldahl nitrogen.

or effluent, and average 50 lb of N, 27 lb P, and 48 lb K per ton of litter. The material is fairly light in weight, containing an average of 22% moisture, and is easily transported in bulk loads.

Research with Poultry Manure

In addition to analyzing livestock wastes and interpreting the results, the LWTL assists in research to refine the recommendations from the lab. Field research has been conducted largely with vegetable crops to evaluate manure utilization and to field test the manure management recommendations from the lab. Two field research studies were conducted in 1996 (Hochmuth and Hochmuth, 1996, 1997; Hochmuth et al., 1997) at the UF-IFAS Suwannee Valley Research and Education Center (now the North Florida Research and Education Center-Suwannee Valley) in Live Oak, Fla. These reports also are available on the world-wide-web at http://nfrec.ifas.ufl.edu. Details about the experimental methods and results are available in the reports. The experiments were conducted with eggplant to determine optimum rates of poultry manure fertilization and to compare eggplant yield responses to manure and chemical fertilizers. Poultry manure was applied at rates from 6 to 18 tons/acre. In both years of research with eggplant, poultry manure at 6 tons/acre resulted in yields equivalent to crops receiving greater amounts of manure. Further, yields with 6 tons/acre of manure were equal to yields with the recommended rate of chemical fertilizer. Using the UF-IFAS recommended rates of fertilization, based on the N content in the manures, resulted in optimum eggplant fruit yield.

In summary, the University of Florida provides nutrient analyses with interpretations of the results for livestock waste materials and makes recommendations for the use of the livestock wastes for fertilizer. The UF-IFAS LWTL provides recommendations for manure management and carries out educational programs for livestock farmers and crop farmers in Florida. The work of the LWTL is funded by a consortium including UF-IFAS, several governmental agencies, and agricultural industries. The programs from the LWTL provide the basis for optimum management of livestock wastes in concert with maintaining the high quality of the water resources in the MSRA in northern Florida.

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